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RESEARCH MEMORANDUM

A RETENTION MODEL FOR NAVY PHYSICIANS

Joyce S. McMahon

A Division of CNA Hudson Institute

CENTER FOR NAVAL ANALYSES

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ABSTRACT

In recent years, the Navy has indicated concern for the retention patterns observed for physicians. Some specialties show relatively low retention compared to others, and the aggregate retention rate for specialists has declined. This research memorandum discusses the derivation of a model to estimate the influence of various factors on unobligated physicians' decisions to stay in or to leave the Navy. The main analytical issue is the quantification of the role of the positive and growing civilian-military pay differential on the retention of Navy physicians.

EXECUTIVE SUMMARY

INTRODUCTION

Attention has focused recently on the retention patterns of Navy medical personnel and the attractions of alternative civilian employment. The growth of the civilian-military pay gap for fully trained specialist physicians is of particular concern because of the high cost of training such physicians and the importance of retaining experienced physicians to staff the teaching hospitals. Such concerns led the Navy to request CNA to examine the factors that influence physician retention.

Although many factors influence military physicians' decisions concerning civilian employment, the issue of financial considerations is important from a policy point of view. It is possible to quantify the expected effect of compensation, to modify the level of compensation, and to make such adjustments relatively quickly. Working conditions also may be important to physicians, for example, but they are difficult to quantify and analyze, and they change very slowly.

The focus of this analysis is to assess the sensitivity of retention of fully trained specialists in the Navy to civilian-military pay differentials. Although the influence of other factors must be controlled for to correctly assess the role of pay, the policy focus is on the expected retention impact of reducing civilian-military pay differentials. Illustrative pay proposals for military pay increases for physicians are analyzed with regard to the cost of such proposals and the expected results with respect to first-year retention of physicians by specialty. These illustrative proposals provide examples of how the model can be applied.

DATA

The Bureau of Medicine Information System (BUMIS), for FY 1983 through FY 1987, is used to construct the population of fully trained specialists who were on active duty during this period. Each person's military pay is calculated and compared to civilian alternative pay derived from survey data for faculty physicians from the American Association of Medical Colleges (AAMC). The AAMC data come from a comprehensive survey, which is large enough to support income information for 22 physician specialties. Although the analysis is based on Navy physicians, the compensation structure is the same for all military forces, and recommendations should be generally applicable to the Army and Air Force.

PAY DIFFERENTIALS AND RETENTION

The average military-civilian pay ratio for fully trained Navy specialists has dropped from 90.8 percent to 79.1 percent over the period from FY 1984 to FY 1988. In FY 1988, the average pay gap for unobligated fully trained Navy specialists was $24,600, while the range was from $1,200 for pediatricians (excluding neonatology and pediatric cardiology) to $117,200 for the average thoracic/cardiovascular surgeon. Furthermore, the size of the pay gap increases with experience level.

The existence of a positive and growing civilian-military pay gap is likely to have a detrimental effect on the retention of Navy physicians. As the pay gap increases, more unobligated Navy specialists may choose to leave the Navy for civilian employment, other factors being equal. The physicians most likely to leave are those with the higher civilian alternative incomes, so specialties such as surgery may face serious retention and turnover problems.

There are indications in the aggregate and for individual specialties that retention for unobligated physicians is already a problem. Some specialties have high and stable retention patterns, whereas others show yearly retention rates that are quite low. Anesthesiologists, for example, have yearly retention in the range of 54 to 66 percent during the period from FY 1984 to FY 1987, compared to 82 to 83 percent for pediatricians.

Recent changes in retention patterns suggest that a potentially serious retention problem may be emerging. The retention rates for unobligated physicians and specialists dropped slightly in FY 1987 and FY 1988. In addition, retention rates at the end of initial obligation, a career decision point for physicians in the Navy, also declined sharply. For specialists completing an initial obligation, retention decreased from 47 percent to 34 percent between FY 1984 and FY 1987.

MODEL

Physician retention is analyzed using a model that links various characteristics of fully trained specialists to the observed probability that they will leave the Navy. Although many factors affect the choice of military versus civilian employment, the model focuses on the civilian-military pay gap influence on the decision to leave the Navy. Other factors in the decision-making process also are considered to obtain unbiased and realistic estimates of the influence of pay.

Variation in the pay gap is observed across physicians within a specialty and across specialties from FY 1984 to FY 1987. Other factors considered are personal characteristics, such as family responsibilities (dependents), age, and minority status, years of service toward retirement, an observed propensity for military life (based on repeated decisions to stay in the Navy by the same unobligated physician), and the

source of entry of the physician into the Navy. Results of the model are used to analyze the sensitivity of physician retention to changes in the pay differentials for 22 specialties.

The model predicts the likelihood that an individual specialist will decide to leave the Navy at a given decision point. Each unobligated physician is assumed to make a decision once each fiscal year. The dependent variable has a qualitative nature, that is, a physician leaves or stays, but there is no inherent quantitative interpretation of the decision.[1] The appropriate estimation technique is a logistic analysis that deals with the qualitative nature of the decision variable. Multiple regression does not have good estimation properties under these circumstances.

RESULTS

The estimated model verifies that higher civilian-military pay differentials are related to increased probability of leaving the Navy, other factors held constant. Among the other factors, having dependents or being a scholarship entrant are associated with increased probability of leaving. Deferred-scholarship students, who complete civilian residencies before their active duty status, are more than twice as likely to choose to leave as are non-deferred-scholarship students. Higher rank or age and being black or female are associated with decreased probability of leaving the Navy. As a physician approaches retirement eligibility, the probability of leaving diminishes, but it increases sharply after 20 years of service.

The sensitivity of specialists' decisions to leave with respect to civilian-military pay differentials is analyzed for 22 specialties. Sensitivity to pay differentials is relatively high for surgical specialists and quite low for family practice physicians and pediatricians. In general, those specialties with large pay gaps demonstrate the greatest sensitivity to reduction of the pay differential.

PAY PROPOSALS

The current pay plan of 1989, the baseline plan, involves an increase in regular military compensation plus substantial increases in incentive special pay for specific specialties. For comparison purposes, the most simple illustrative plan is to eliminate the civilian-military pay gap. Increasing military pay to the comparable civilian median would require an average raise of about $22,400, or a 27-percent

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1. A decision variable is coded 0 or 1 but has no quantitative measurement scale. Pay and age, for example, can vary along a scale and are termed quantitative. A decision to leave or stay has no measurement scale because a person cannot be observed to have an outcome between staying and leaving.

wage increase on average. A variation is to raise military pay to 90 percent of the comparable civilian median, which would require an average raise of about $13,300, or a 16-percent increase on average.

The direct way to compare the pay plans is to consider what would be expected to happen if paying to the median or to 90 percent of the median replaced the FY 1989 baseline pay plan. Based on a model using data from FY 1984 through FY 1987, paying to the median would be expected to convince 64 specialists who would have left the Navy under the FY 1989 baseline plan to remain in the Navy for at least one more year. Paying to 90 percent of the median would be expected to convince 38 specialists who would leave under the FY 1989 baseline plan to stay in the Navy. However, these estimates of sensitivity of retention to pay may be too low because they are based on data with little variability in pay across specialties and time. Relatively large pay increases may stimulate more responsiveness among physicians than can be observed in the time frame of the data.

Paying to the alternative civilian median would cost approximately $23.3 million, while paying to 90 percent of the median would cost about $13.7 million. The plans involve a considerable increase in cost because any pay increase will compensate many physicians who would have stayed without a pay increase. However, it would cost approximately $15.2 million to restore the buying power of physicians' income, which has eroded between 1 October 1980 and 30 September 1987 [1]. Considering the cost of the pay proposals against the cost of restoring lost purchasing power, the illustrative pay increases proposed are relatively modest adjustments to the average current pay of $83,000 for unobligated specialists.

CONCLUSIONS

The logit model verifies that there are many factors that influence the decision by physicians to leave the Navy for civilian employment. The civilian-military pay gap does have a significant influence on the probability that a specialist will decide to leave the Navy. Indications are that increasing pay to decrease the civilian-military pay gap can be an effective policy tool and should result in increased retention of specialists.

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INTRODUCTION

Attention has focused recently on the retention patterns of Navy medical personnel, with concern for the relative attractiveness of alternative civilian employment opportunities. Medical personnel, unlike many military employees, find that their skills are readily transferable to the civilian sector. Therefore, if there is dissatisfaction with military working conditions, lifestyles, and/or compensation, the medical field may be faced with low retention and high turnover. In particular, if civilian pay is higher than military pay, it can be expected that the highest quality Navy personnel will face the best civilian alternatives and will be the most likely candidates to leave the Navy.

The category of fully trained specialist physicians is of particular concern to the Navy. It is very costly, both in terms of time and money, to develop a fully trained specialist, and it is important to the Navy that experienced specialists are available to staff the teaching hospitals where young physicians receive training. Low retention of specialists will create problems in adequate staffing of hospitals and in allocating experienced physicians to teaching slots in the training facilities. Concern for the retention patterns observed caused the Navy to request CNA to examine the factors that influence physician retention.

Many factors influence physicians' decisions to either pursue a military career path or seek civilian employment once their obligated service is completed. Personal characteristics, family considerations, working conditions, and financial circumstances will all influence physician retention decisions. From a policy viewpoint, financial considerations are a significant issue because pay can be adjusted quickly and the effect on retention can be estimated. Working conditions, such as the amount of support staff, are important to physicians, but such matters are slow to change and difficult to quantify, and it is not easy to predict the retention implications.

The focus of this research memorandum is to analyze the sensitivity of retention of fully trained specialist physicians in the Navy to pay differentials between the civilian sector and the Navy. Other factors that influence retention decisions are controlled for in the model so that unbiased estimates of pay elasticities can be obtained. The model is then used to estimate first-year retention effects of increasing military pay, other factors held constant. Rather than stress the documentation of the existence of a retention problem, this publication concentrates on the policy issue of how pay increases can be translated into retention improvement. The model is also used as the analytical basis of retention forecasts for [1]. Related issues are discussed in more detail in [2, 3, 4, 5].

DATA

The model specification is constrained by the availability of data and the scope of the project. Because a critical variable to be measured is the size of Navy physicians' income compared to civilian income, it is important to be able to identify total income for a Navy physician as well as to be able to calculate the appropriate alternative civilian income. It is also crucial that the data support the ability to analyze physicians by specialty because income across specialties in the civilian sector varies substantially.

Information on Navy physicians, their background, and their pay is available from the Bureau of Medicine Information System (BUMIS). BUMIS data for FY 1983 through FY 1987 are used to construct the population of fully trained specialists who were on active duty during this period. CNA maintains a data base that provides calculations on income, both monetary and imputed, for Navy physicians. The data base also contains background information on the physicians, including family characteristics, source of entry into the Navy, and current career progression. The data base currently spans the time frame from FY 1984 to FY 1987 for all key variables. Thus, variation in income can be observed across physicians at a point in time and for individual physicians across time.

The calculation of pay for Navy physicians is based on regular military compensation (RMC) and four types of special pay: Variable Special Pay (VSP), Board Certified Pay (BCP), Additional Special Pay (ASP), and Incentive Special Pay (ISP). The BUMIS data, which do not contain complete information on physicians' pay, are augmented by constructing each physicians' military pay from pay schedules. The constructed pay variable for RMC includes base pay, basic allowance for quarters (BAQ), variable housing allowance (VHA), basic allowance for subsistence (BAS), and the federal tax advantage due to the nontaxable status of the BAQ, VHA, and BAS, plus a dependency allowance. A detailed discussion of the calculation of pay for Navy physicians can be found in [1].

Although the data contain variation in income across time and physicians, limitations are imposed by the time frame available for analysis and the nature of military pay. The major source of variation in pay by specialty is derived from variation in the special pays. For FY 1984 through FY 1987, BCP, ASP, and VSP have been held constant, and ISP has not been changed very much. The data would be more useful if more variation in pay were available.

The other side of the financial consideration is the Navy physician's best alternative position in the civilian sector. Here practical constraints lead to the choice of survey data gathered for faculty physicians from the Association of American Medical Colleges (AAMC). The AAMC data come from a comprehensive survey, and the data set is large enough to provide income information for 22 physician specialties, by experience ranking, over a number of consecutive years. The other

data sources for civilian income for physicians were rejected for a number of reasons. The American Medical Association (AMA) survey data will support analysis of only nine specialties and are not as current as AAMC data. Data from the journal, *Medical Economics*, are not consistent by specialty from year to year, not current, and not available by experience level.

One consideration in choosing an alternative civilian income comparison is to select a conservative metric. Although it is difficult to compare the three civilian data sources (because of differences in specialties, sample size, experience stratification, and employment categories), it seems that the AAMC data also pass the test of a conservative measure of income. On average, the AMA and *Medical Economics* data indicate higher civilian alternative income than is apparent from the AAMC data. Further comparisons are discussed in [1].

For the AAMC data, Navy physicians were mapped into civilian counterparts on the basis of experience and specialty. Military pay was compared to civilian income for assistant, associate, and full professors for 22 specialties from FY 1984 to FY 1987. Appendix A details the 22 specialties examined and their precise composition. The 22 specialties cover 93 percent of the fully trained specialists in the Navy. The remaining 7 percent of Navy specialists did not have good civilian counterpart data for various reasons.

PAY DIFFERENTIALS

A comparison of pay for Navy physicians and their civilian counterparts reveals unusual patterns of pay differentials across specialties and across time. Some of these patterns are caused by the relatively rigid and flat pay profiles characteristic of military pay. Overall, the average military-civilian pay ratio (military pay/civilian pay) for fully trained Navy specialists has declined from 90.8 percent in FY 1984 to 79.1 percent by FY 1988. The average pay gap for unobligated fully trained Navy specialists was $25,200 in FY 1988. For some specialties the gap was very low, with pediatricians (excluding neonatology and pediatric cardiology) having a pay gap of $1,200. However, the average thoracic/cardiovascular surgeon had a pay differential of $117,200. In general, the pay gaps increase with experience level for all specialists and are larger for specialties that require extensive training, such as the surgical specialties.

For nonspecialist physicians, the pattern is reversed. Nonspecialist physicians in the Navy earn higher average salaries than their alternative civilian counterparts. Based on a matching of Navy nonspecialists to civilian resident physicians surveyed by the AMA's Center for Health Policy Research, the civilian-military pay gap moved from negative $14,600 to negative $16,100 between 1982 and 1987 [6].

The general patterns just described demonstrate a perverse financial incentive structure offered by the military for physicians. Navy nonspecialist physicians, who are comparable to civilian resident physicians, are normally under obligation to the Navy to work off the implicit debts incurred during their accession and training. During this period, they are being compensated at higher rates than their civilian counterparts. Navy fully trained specialists, who are more likely to be unobligated or approaching unobligated status, conversely are paid less than their civilian counterparts on average. Further, there is no scheduled increase in compensation for Navy physicians who complete their obligated service except through normal annual increases and grade adjustments.

The analysis of retention of Navy physicians focuses on the fully trained specialists who are unobligated. Clearly, obligated physicians are not voluntarily making a decision to stay in the Navy, so it is inappropriate to include these physicians in the analysis. Also, the unobligated nonspecialists are excluded from the analysis because their civilian-military pay gap is negative. These Navy physicians earn more than their civilian counterparts, so decisions to leave or stay in the Navy must be made on the basis of nonmonetary considerations or on the basis of the future expected civilian-military pay gap if these physicians stay in the Navy and train for a specialty.

RETENTION

Retention of Navy physicians becomes an issue when a specialist has completed the period of obligated service. Theoretically, the obligated service is required for a period of time that will permit the Navy to recover the costs associated with attracting and training the physician. This recovery of costs is assumed to be obtained by requiring the physician to work for the Navy for a period of years at below-market wages, with the period of obligation differing by specialty to reflect each specialty's average accumulated accession and training costs. As noted, however, obligated nonspecialists receive higher pay than the resident physicians who are their civilian counterparts. In general, by the time a Navy physician achieves specialist status, the civilian-military pay differential becomes positive, so that the obligated service period of a specialist reflects the intended pattern of paying back incurred debts.

Examination of retention for unobligated specialists reveals the existence of large variation across specialties. Over the time frame of FY 1984 through FY 1987, pediatricians as a group show very stable retention rates of 82 to 83 percent, while anesthesiologists show retention rates of 54 to 66 percent [1]. Although no clear trend is apparent with regard to retention within specialties over time, it is obvious that some specialties consistently suffer from high turnover while other specialties maintain a more stable situation.

In the aggregate, there are some indications of a trend with regard to retention over time, as can be seen in table 1. Aggregate retention for unobligated fully trained specialists and unobligated physicians had begun to drop by FY 1987 and FY 1988, after being stable in earlier years. For physicians at the end of their initial obligation period, a key decision point for leaving the Navy versus choosing a career path [2], retention drops 10 percentage points from FY 1986 to FY 1987 for unobligated fully trained specialists. For general medical officers (GMOs), who do not immediately specialize and face simply a contract obligation, retention drops by 5 percentage points from FY 1986 to FY 1987 and by 25 percentage points between FY 1984 and FY 1988.

Table 1. Retention rate of unobligated Navy physicians, FY 1984 through FY 1988 (population size in parentheses)

	Retention rate (percentage) by fiscal year				
Physician group	1984	1985	1986	1987[a]	1988[a]
Unobligated physicians[b]	76 (1,500)	76 (1,573)	76 (1,583)	74 (1,569)	72 (1,463)
Unobligated specialists[c]	74 (1,029)	74 (958)	73 (979)	72 (950)	70 (937)
Physicians at the end of initial obligation					
Specialists	47 (168)	45 (257)	44 (264)	34 (238)	33 (261)
General medical officers (GMOs)[d]	56 (41)	51 (117)	38 (81)	33 (98)	31 (146)

a. Calculations included an adjustment to delete physicians in executive medicine to provide comparability to data from prior years for the category of unobligated specialists.
b. Unobligated physicians include all physicians who reach the end of an obligation before or during the fiscal year.
c. Unobligated specialists include all specialists who reach the end of an obligation before or during the fiscal year; 22 specialties are included.
d. Excludes GMOs with specialty training.

The evidence for physicians at the end of first obligation presents a picture of a developing problem that has not as yet drastically affected overall retention rates. If more and more physicians are leaving at their first opportunity following contract obligation (general medical officers) or contract plus training obligation (specialists), this trend eventually will cause the overall retention rate to begin to fall sharply. A preliminary indication of this can be seen for the set of fully trained specialists that can be matched to civilian counterpart physicians and for which valid data are available for all key variables. For this data set, the retention rate has dropped from 74 percent for FY 1984 to 70 percent for FY 1988. For the same data set, in FY 1987, 66 percent of the specialists were unobligated, whereas preliminary information from FY 1988 indicates that only 62 percent were unobligated.

The inventory of fully trained specialists has decreased somewhat in recent years. This slight decline is not inconsistent with the evidence of significant declines in retention because of the high number of new physicians from the training pipeline and through direct accessions in each year of the time period in question [3]. The inventory in a given year typically consists of about 21 to 25 percent new specialists from the pipeline and direct accession route, which implies a high turnover of physicians. In addition, at the beginning of FY 1989, the Navy faced a gap of 148 specialists based on billet authorizations as of the end of FY 1990.

MODEL

The analysis of retention is based on the ability to define and quantify the critical factors that affect career decisions of Navy fully trained specialists. Because decisions to stay in the Navy or leave are made on an individual basis, the unit of observation is the physician at a point in time in which a decision can be made. The physician is considered eligible to stay or leave for the first time during the year in which the end of initial obligation is reached. As long as the physician remains unobligated and in the Navy, each new fiscal year is treated as another observation where a decision must be made to stay in the Navy or leave. The analysis is conducted for all fully trained specialists in the Navy who can be matched by experience and professional specialty to a civilian counterpart physician.

The purpose of the model is to predict the likelihood that an individual specialist will, at a given decision point, decide to leave the Navy. A decision point is assumed to occur once each fiscal year. Although it is impossible to measure all factors that will influence a physician's decision, it is important to describe and quantify the

decision-making process as fully as possible. In this way, the model can provide an unbiased estimate of the effect of certain factors on retention, holding constant for the influence of other considerations.[1]

The first application of the model is to develop the ability to predict, over a group of physicians of known characteristics, how many are likely to leave in a given year. A second application is to be able to predict how the retention of the group of physicians is likely to be affected if a factor in the decision-making process is altered as a matter of policy.

Factors That Influence Retention

The decision to leave or stay in the Navy can be assumed to be a decision to accept or seek civilian employment rather than Navy service in almost all circumstances. In very few cases would a decision to leave the Navy not be concurrent with a decision to practice medicine in the civilian sector. Therefore, one of the major factors to consider for a Navy physician is the amount of pay in the Navy compared to the pay that can be earned in civilian employment as a physician. The larger the civilian-military pay gap, the greater the incentive for a Navy physician to leave for civilian employment.

Other factors will also influence the decision to leave or stay in the Navy and must be included in the estimation of the model to correctly assess the true effect of pay differentials. First, it is likely that personal considerations will affect the decision to leave or stay in the Navy. Family responsibilities, such as children or a spouse, may affect the physician's preference for civilian versus military employment. In general, Navy affiliation restricts voluntary mobility of the physician while occasionally requiring involuntary mobility. The restriction of voluntary mobility may limit the choices available for children's education and the employment choices open to a spouse. Involuntary mobility may cause disruption of families, including the interruption of school years for children and the termination of a spouse's investment in a career path. The presence of dependents likely would lead to a greater probability that a physician would seek civilian employment.

Other personal characteristics may influence the decision to leave the Navy. A person's minority status may have an impact on the relative desirability of Navy employment. The direction of this influence depends on the perception by nonwhites and women as to whether professional opportunities are better in the Navy or in the civilian sector. Other factors held constant, age may have an influence on the relative attractiveness of Navy life. Possibly, older physicians are more likely to have a clear perspective of civilian alternatives; therefore, they

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1. As long as any remaining omitted factors are not correlated with the variables in the model, the estimated model will be unbiased.

will be more likely to have made an informed choice concerning joining the Navy and will be less likely to leave than younger physicians. Also, it is assumed that the higher the rank of the physician, the less likely a leave decision will be observed. Presumably, rank is associated with positive nonpecuniary rewards and career status, which will encourage a physician to value Navy employment.

One of the hardest factors to consider is the effect of potential military retirement on the decision to leave the Navy. Because military personnel can retire after 20 years of creditable service with substantial benefits, and can then draw these benefits while also pursuing civilian employment, military retirement can be a strong incentive to stay in the Navy. However, to put retirement into the context of the present value of expected future benefits is very difficult and is not feasible for the current model.

To develop a financial interpretation of the value of retirement, it is necessary to determine the discounted value of retirement for both civilian and military employment. It is feasible to quantify the military retirement parameters, but the data on civilian employment do not support a similar comparison. Therefore, it is assumed that, other factors held constant, the more years of service a Navy physician has, the less likely it is that a decision to leave will be observed, up until 20 years of service are attained. After 20 years of service, it is assumed that the observed probability of a decision to leave will increase. This interpretation controls for the effect of military retirement incentives without putting the incentives into the framework of discounted present value or explicitly considering civilian retirement benefits, which would be a complex and lengthy procedure.

Another factor that is difficult to quantify is the existence of a personal preference for Navy life. Because our model assumes that a decision to leave or stay is made on an annual basis, and the data cover the time period FY 1984 to FY 1987, it is possible to observe repeated decisions by the same physician assuming that the initial decision was to stay in the Navy. Although this offers limited insight into individual taste and preference, it can be assumed that, other factors being accounted for, repeated observations on the same unobligated physician are indicative of a positive preference, or taste, for Navy life. One decision to stay, therefore, will increase the observed probability of subsequent decisions to stay.

The source of entry of the Navy physician also has the potential to be a strong predictor. Although it is difficult to anticipate which classifications of source of entry will be associated with a greater likelihood of choosing to leave the Navy, it is possible to categorize source of entry and investigate the issue. The categories chosen to investigate are deferred-scholarship students, non-deferred-scholarship students, physicians under the early commission plan, physicians under the Berry plan, and direct accession along with other miscellaneous source-of-entry physicians. Deferred-scholarship students complete a

civilian residency before the start of active duty. Under the early commission program, students are in the inactive reserve during medical school, but receive no pay or allowances during this period. Berry-plan physicians were brought in under the selective service system before July 1973.

Other factors that may influence a decision to leave the Navy include personal dislike of superior officers and dissatisfaction with working conditions. For example, physicians may feel that they have insufficient support staff or not enough variety of caseloads in the Navy. Not only is it extremely difficult to obtain information on such matters, it is nearly impossible to quantify and measure such considerations. Failure to account for these factors can be expected to weaken the overall ability to predict whether a given Navy specialist will choose to leave the Navy, but across all physicians the effects should not add bias or degrade the predictive ability and interpretation of the model.

An important factor of interest from a policy perspective is the size of the civilian-military pay gap. The other factors discussed are important primarily as controls to ensure that an accurate estimate of the impact of pay differentials on retention are obtained. In addition, some of the other variables are of interest for their predictive ability. For example, knowledge of the relationship between source of entry and the probability of leaving offers insight into expectations for future retention and the appropriate mix of entry to promote good force management.

Technique

The dependent variable is derived from an observation of an individual physician at a decision point, either at the end of an obligation period or at yearly intervals after the physician becomes unobligated and fails to incur further obligation. For an observation of an individual physician at a decision point, the physician will either leave or stay. A decision to leave is arbitrarily coded as a "1," whereas a decision to stay is coded as "0." Because the dependent variable takes on a value of 0 or 1, meaning that an event either occurs or does not occur, the appropriate method to estimate the model is logistic analysis [7].

Because of the nature of the dependent variable, the logit technique is a more appropriate estimation procedure than multiple regression. When the dependent variable has a yes-or-no nature, that an event either does or does not occur, there is no natural quantitative interpretation of what a 0 or 1 means. There is no quantitative scale, as would exist for age or weight, for example.

In this case, the application of a multiple regression technique is inappropriate for a number of reasons. To cite one of the more important considerations, the use of a multiple regression model to predict

leave-or-stay decisions may result in predicted values greater than 1 or less than 0 in some cases. Because this is unacceptable, the preference is a nonlinear technique, such as logit, which is specified so that all predictions fall inside the range of 0 to 1, meeting the test of making realistic predictions.

The basic model can be written as:

$$Y = a + \beta X + \epsilon \ ,$$

where

Y = 1 if the specialist chooses to leave the Navy
Y = 0 if the specialist chooses to stay in the Navy

X = a vector of factors that may influence the choice to leave the Navy or stay

β = a vector of coefficients for the X factors

a = a constant term

ϵ = error term .[1]

If the model is estimated by ordinary least squares, the predicted values for the dependent variable, which represent the probability that the specialist leaves the Navy, may sometimes be greater than 1 or less than 0. In addition, the model as specified contains heteroskedasticity (systematic differences in the size of the variance), so weighted least squares would be appropriate. However, the method of weighted least squares is quite sensitive to errors of specification, and the error distribution is not Normal, so standard estimation tests are not valid. In general, methods to adjust the model so that linear estimation techniques can be used are not very successful [8]. Therefore, a nonlinear estimation technique is applied to the basic model. For details of the transformation of the model into a nonlinear estimation methodology, see appendix B.

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1. The standard assumption that the error term is an independently distributed random variable with a mean of 0 is not theoretically justified because of the nature of the data. Combining time series and cross-section data greatly increases precision of estimation but also introduces the possibility of covariance of error terms across time for the same individuals, or a systematic time trend influence on the error structure. Same, the variable that reflects repeated observations of the same physician, acts as a control for multiple observations on the same person. Tests for the influence of time period revealed no significant impact of time on the estimated model. In general, examination of the residuals from the estimated model indicate no problems with the error term.

Because the dependent variable takes on a value of 0 or 1, the predicted value of this variable is the probability that a 1, or a decision to leave, will be observed, given the effects of the various explanatory variables examined. There are two direct benefits of this modeling technique: it will be possible to evaluate how well the data support the prediction of individual physicians' behavior, taken as a group, and it will be possible to isolate the effect of pay differentials on the probability of leaving by filtering out the influence of other factors that may affect physicians' decisions.

RESULTS OF RETENTION MODEL

The estimation of the model was accomplished using the Statistical Analysis System (SAS) LOGIST procedure. The model proved to be very stable, and results were not sensitive to deletion of variables or specific functional form. Tables 2 and 3 present the results of the logit model and definitions of variables, respectively. Means and standard deviations of variables are given in appendix C. Briefly, the results verify that the larger the pay differential between the civilian sector and comparable military physicians, the higher the probability of the military physicians' choosing to leave the military, other factors being held constant. Therefore, higher pay differentials are associated with lower retention probabilities.

Among the other factors being controlled for, it is found that having dependents is associated with a higher probability of leaving. From source-of-entry considerations, both deferred- and non-deferred-scholarship entrants are more likely to leave the Navy than is the case for direct accessions and miscellaneous entrants (the control group). Deferred-scholarship students are more than twice as likely to choose to leave as non-deferred-scholarship students. Early commission and Berry-plan participants are less likely to leave than the control group.

Being older, having a higher rank, being black or female, and nearing retirement eligibility are associated with a lower probability of leaving. It is possible that minority physicians expect to face more employer or patient discrimination in the civilian sector than is present in the Navy. Once a physician has more than 20 years of service toward retirement (Yos5), there is a sharply increased probability of leaving. In addition, those with a taste for the Navy, denoted by Same, have a diminished probability of leaving. The preceding results are statistically significant at the .05 level of significance or better.

Table 2. Results for logistic regression analysis for FY 1984 through FY 1987

Variable	Coefficient	Chi-square[a]	P-value[b]
Intercept	2.0527	25.98	.0001
Paydif	.00001214	31.64	.0001
Same	-.5718	45.57	.0001
Age	-.0325	9.69	.0019
Yosd3	-.3714	10.77	.0010
Yosd4	-1.3005	43.52	.0001
Yosd5	1.2874	44.25	.0001
Depend	.3313	7.19	.0073
Ngrade	-.4071	18.33	.0001
Def	.8875	25.67	.0001
Ndef	.3184	8.44	.0037
EC	-.3155	4.20	.0405
Berry	-.6157	8.28	.0040
Mint	-.3186	10.05	.0015

NOTES: Model chi-square = 669.74 with 13 degrees of freedom; (-2 LOG L.R.) P = .0001; sample size = 4,031.

Observations with predicted probability of leaving $\geq$ .40 are classified as leaving for prediction purposes. A leave = a positive observation.

Classification results correct prediction = 74.7 percent.
Sensitivity[c] = 47.8 percent.
Specificity[d] = 84.3 percent.
False positive rate[e] = 47.8 percent.
False negative rate[f] = 18.2 percent.

a. Wald chi-square statistic.
b. The probability of incorrectly rejecting the null hypotheses that the coefficient is zero. The smaller this value, the more likely that the coefficient is not zero.
c. Sensitivity = proportion of true positives predicted to be positive.
d. Specificity = proportion of true negatives predicted to be negative.
e. False positive rate = proportion of predicted positives actually negative.
f. False negative rate = proportion of predicted negatives actually positive.

Table 3. Definitions of variables

Variable	Definition
Paydif	Pay differential between civilian alternative income and military income for the fiscal year observed
Same	Indicator variable for "taste" for military service. Dummy variable with 1 for repeat observations on the same physician across the 4 years
Age	Age of physician in years
Yosd3	Dummy variable: 1 indicates 10 or more years but less than 15 years creditable toward retirement at 20 years
Yosd4	Dummy variable: 1 indicates 15 or more years but less than 20 years creditable toward retirement at 20 years
Yosd5	Dummy variable: 1 indicates 20 or more years of service
Depend	Dummy variable: 1 indicates existence of dependents of the physician, either spouse or children or both
Ngrade	Indicator of rank of physician
Def	Dummy variable: 1 indicates scholarship (deferred status)
Ndef	Dummy variable: 1 indicates scholarship (nondeferred status)
EC	Dummy variable: 1 indicates early commission plan
Berry	Dummy variable: 1 indicates Berry plan
Mint	Dummy variable: 1 indicates physician was nonwhite or female

Sensitivity of Retention to Pay Differentials

The most immediate purpose of the model is to evaluate the impact of pay differentials on retention. The policy implications are that, if the pay differential is reduced, on average, for a group of physicians, retention is expected to increase, and the expected amount of increase

in retention can be derived from the estimated logit model. This calculation is described in terms of the elasticity of the probability of leaving with respect to a change in the pay differential, where:

$$\text{Elasticity} = \frac{\text{percent change in the probability of leaving}}{\text{percent change in the pay differential}} .$$

In other words, if the elasticity equaled .5 and the pay differential were reduced by 10 percent, we expect the probability of leaving to be reduced by 5 percent, leading to a predicted increase in retention. The analysis is associating the sensitivity of retention to changes in the relative size of the pay differential, given that other influences have been accounted for in the model.

Aggregate Elasticity

The overall elasticity of the pay differential with respect to the probability of leaving is calculated, in terms of the model, as

$$\text{Elasticity} = (1 - P) * \beta * \overline{Paydif} ,$$

where

β = the estimated coefficient of the Paydif variable

$\overline{Paydif}$ = the mean of the Paydif variable

P = the probability of a leave being observed.

The estimate of the aggregate elasticity for the overall model is approximately .15. With a reduction of the average civilian military pay gap to zero, a reduction of 100 percent, the probability of leaving would be reduced by 15 percent. Because the aggregate probability of leaving from FY 1984 through FY 1987 is approximately 26.4 percent for the estimated model, this would imply that the probability of leaving would be reduced to approximately 22.4 percent (a 15-percent decline).

As an example, suppose the Navy has 1,000 unobligated specialists in a given fiscal year. Based on the data used to estimate the model, 264 specialists on average would be expected to choose to leave the Navy at some point in the fiscal year. If the civilian-military pay gap were closed to zero, only 224 specialists would be expected to leave. The pay increase to the unobligated Navy specialists would result in a saving of 40 specialists who would otherwise be expected to leave the Navy.

Specialty-Specific Elasticities

To permit more specific examination of the model's implications, a pay differential elasticity is calculated separately for each of 22 specialty classifications of military physicians. This procedure differs from the previous methodology in two main ways. First, although the estimated coefficient β for the pay differential variable is dependent on data for FY 1984 through FY 1987, the actual probability of leaving and the observed civilian-military pay gap is based on preliminary data for FY 1988 obtained from the Navy. The advantage of this is to use the most current data available to accurately estimate the current magnitude of the elasticity of the probability of leaving with respect to the pay gap.

Second, although β represents the responsiveness of all specialists to pay differentials, the measurement of the probability of leaving and the size of the pay differential can be calculated separately for each specialty. This permits an elasticity to be estimated for each of the 22 specialties examined. See appendix C for a more detailed explanation.

The results indicate that the elasticity of the probability that a leave is observed with respect to the pay differential is relatively large (.7 or greater) for thoracic and cardiovascular surgeons and for neurosurgeons and is very small for family practice physicians and pediatricians. Estimated elasticities for the 22 specialties are presented in table 4. The results support an intuitive expectation that, in general, those specialties with the largest pay differentials will show the greatest responsiveness, with regard to the probability of leaving (retention), for a specific percentage reduction of the pay gap.

Application of Elasticities to Illustrative Pay Proposals

The elasticities developed using the model are applied to analyze the expected impact on retention of illustrative pay plans. The results of a pay proposal will be to increase not only costs but also retention of physicians by decreasing the probability of leaving. The model permits us to analyze the impact on retention in terms of how many physicians who would have left are expected to be influenced to stay in the Navy. It also indicates which specialties are more likely to show retention increases under the various alternative pay proposals.

Table 4. Elasticity of probability of leaving with respect to pay differentials

Specialty	Elasticity (rounded)
Other pediatrics	.01
Pediatric cardiology	.06
Family practice	.07
Other internal medicine	.09
Psychiatry	.09
Pathology	.12
Neurology	.12
Internal medicine--gastroenterology	.12
Dermatology	.14
Neonatology	.15
Internal medicine--cardiology	.17
Obstetrics and gynecology	.19
Radiology	.27
Anesthesiology	.30
Plastic surgery	.39
Urology	.39
Ophthalmology	.43
Orthopedic surgery	.43
Otolaryngology	.44
General surgery	.45
Thoracic/cardiovascular surgery	.71
Neurosurgery	.72

The most simple example is to assume that the intent is to eliminate the civilian-military pay gap for unobligated specialists and to observe the resulting impact on retention for the Navy specialists. Using civilian pay data from FY 1989, assume that Navy pay for each specialty studied is raised to the comparable civilian median.[1] This requires an average raise (weighted by the sample distribution) of approximately $22,400, representing a 27-percent wage increase. For a more conservative example, raising the Navy pay to 90 percent of the civilian median would require an average raise of $13,300, representing a 16-percent increase.

1. The estimated civilian median used is for the academic year (AY) 1989, and is estimated based on specialty specific income from AY 1985 to AY 1987.

Under the current military pay plan in effect for FY 1989, for the 22 specialties considered, the ending inventory for FY 1989 is expected to be approximately 1,676 specialists, 1,043 of which will be unobligated. The alternative pay plans can best be evaluated by assuming that they go into effect at the same time as the FY 1989 military pay increase and are in addition to the FY 1989 pay increase. Although this is unrealistic, there is no way of knowing what pay plan, if any, will be chosen and when it would become effective during the fiscal year.

Using the specialty-specific elasticities, if the unobligated specialists receive military pay increases to bring them on average up to the civilian counterpart median, it is projected that the FY 1989 year-end inventory would increase to 1,740 specialists, at a total increase in cost of $23,300,000. This means that 64 specialists who would have left the Navy are expected to change their minds and stay, which would increase the projected year-end inventory by 3.8 percent. If the pay increase is tailored to bring the unobligated Navy specialists up to 90 percent of their civilian counterpart pay, the total increase in cost is $13,700,000, which will mean that 38 specialists who would have left the Navy will be expected to change their minds and stay. In this case, the projected year-end inventory would increase by 2.3 percent.

It must be noted that the estimated sensitivity of physician retention behavior with respect to decreasing the civilian-military pay gap is based on data that do not contain much variation in military pay by specialty. Also, over the time frame observed, there were no major increases in military pay for physicians. It is possible that the estimated elasticities will not fully reflect the sensitivity of physician retention to the increases in military pay proposed by the illustrative plans.

Although the increase in cost seems high, the pay plan itself is not unreasonable because it is based on comparable civilian pay and yields believable results. Approximately 70 percent of unobligated specialists stay in the Navy on average, based on decision points once each fiscal year, so the cost of increasing retention can be expected to be high viewed on a per-physician-saved basis. Any pay increase will compensate many physicians who would have stayed anyway. However, the plan to pay 90 percent of the civilian median involves an average raise of $13,300, or a 16-percent increase, which is a relatively modest adjustment to the average FY 1989 pay of $83,000 to unobligated specialists.

In contrast, the Navy's proposed cost-of-living pay plan would cost approximately $15.2 million to restore lost purchasing power in physicians' salaries from 1 October 1980 to 30 September 1987 [1]. This would compensate for the eroded buying power of special pays, which remained constant over this time frame except for ISP. Compared to this cost-of-living adjustment, the 90 percent of the median plan would be less costly, and the full median plan would cost $8.1 million more. In

addition, paying toward the median would tend to adjust Navy specialists' salaries toward the relevant civilian alternatives, diminishing incentives to consider civilian employment.

As a check on the specialty-specific elasticity evaluation, the analysis is repeated using the aggregate elasticity for the 90 percent of the alternative civilian median pay plan. Because the average pay gap in FY 1989 is approximately $22,400, the aggregate elasticity of the probability of leaving with respect to the civilian-military pay differential is about .2. With approximately 30 percent of the unobligated specialists leaving at a given fiscal year decision point, the probability of a leave being observed will drop to about 25.5 percent with the 90 percent of the median pay plan. This implies that about 36 specialists who would have left the Navy will decide to stay.

The aggregate analysis predicts that the 90 percent of civilian pay plan will save 36 specialists, and the analysis broken out by specialty predicts saving 38 specialists, so the model appears to be working consistently. Analysis by specialty permits the increase in physicians saved to be analyzed to see if the additional physicians are in the most desirable specialties. Table 5 presents the inventory (including obligated physicians) expected by specialty under the current pay plan and under 90 percent and 100 percent of the civilian median pay.

Some specialties that have very small civilian-military pay gaps are unaffected by the proposed pay increases and, therefore, show no expected increase in retention. Those specialties most sensitive to pay increases in terms of increased retention are radiologists, anesthesiologists, general surgeons, and surgical specialists. Paying the full median would mean that more specialists receive raises and that the raises received would be higher, leading to increased retention over the plan to pay 90 percent of the median.

Sensitivity of Functional Form

The results obtained are not substantially affected by the specific formulation of the variables chosen to enter the equation. In addition, dropping variables or adding additional factors also seems to leave the basic results intact. A more serious test, however, is to consider alternative functional forms of the key variable for policy, the civilian-military pay gap.

In examining the data over four years, a criticism of the pay gap variable is that the size of the gap grows as a function of inflation. Although inflation is not very strong for the time period used to estimate the logit model, it is true that some growth in the pay gap variable would be expected to occur through inflation even if real incomes were constant. Theoretically, the civilian and military income data could be deflated to reflect real income over the entire time period, but the choice of the correct deflator factor(s) is open to some debate.

Table 5. Projected inventory of Navy specialists for alternative pay plans: end of FY 1989[a]

Specialty	Current military FY 1989 pay	Pay pegged to civilian median	
		90 percent	Full
Family practice	209	209	211
Pediatric cardiology	4	4	4
Internal medicine--cardiology	22	23	23
Pathology	71	71	73
Psychology	96	96	97
Radiology	78	83	85
Obstetrics and gynecology	107	109	111
Anesthesiology	132	137	139
General surgery	144	150	153
Neonatology	12	12	12
Other pediatrics	192	192	192
Internal medicine--gastroenterology	14	14	14
Other internal medicine	242	242	245
Neurosurgery	15	15	16
Orthopedic surgery	112	119	122
Urology	33	36	37
Otolaryngology	49	51	52
Ophthalmology	63	66	67
Thoracic/cardiovascular surgery	6	8	9
Dermatology	36	36	37
Neurology	30	30	31
Plastic surgery	10	11	11
Total	1,676[b]	1,714[b]	1,740[b]

a. Includes obligated and unobligated specialists.
b. Numbers may not add to totals because of rounding.

Another way to deal with this issue is to define the pay differential as a ratio. If the discrepancy between military pay and civilian pay is calculated as military pay divided by comparable civilian alternative pay, inflation will be a common factor that is cancelled by the division. This functional form for the definition of the pay discrepancy between the military and civilian sectors was used by the Rand

Corporation in 1975 and 1985 [9]. It was also used for the Health Professionals Special Pays Study (HPSPS) [10] to estimate an earnings model used to estimate how physicians might choose between leaving or staying in military practice.

The HPSPS analysis was developed for a different set of physicians and used different data and different right-hand-side variables than the analysis performed by CNA. The elasticity derived from the HPSPS model was not the same as the elasticity for the pay differential described earlier. The HPSPS elasticity was for the percentage change in the probability of staying, as a function of the percentage change in the ratio of military to civilian pay. In addition, the specialty-specific elasticities derived relied on specialty-specific information for retention, but the specialty-specific size of the military to civilian pay ratio was not a factor.

In spite of the obvious differences in the model derivation, the CNA model was reestimated using the natural log of the ratio of military to civilian pay as an independent variable, replacing the civilian-military pay gap. The fit of the model changed only slightly, with the other independent variables retaining their general magnitude, sign, and significance.

The most interesting result is the prediction of the elasticity derived from this formulation of the model. Using the elasticity formula demonstrated in the HPSPS analysis, the CNA data yield a result of .83, which is very close to the result of .70 cited by HPSPS. Further, when this formulation of the elasticity is applied to the data to predict the first-year retention effect of raising the military-civilian pay ratio to 1, the equivalent of reducing the civilian-military pay gap to 0, the model predicts that the probability of leaving will be reduced by approximately 20 percent. This is essentially the same result obtained by the original CNA model.

Even though the data, methodology, and elasticity derived from this paper and the HPSPS analysis differ, the end result of the HPSPS formulation of the pay difference is almost identical to the results obtained by CNA. This is strong evidence of the validity of the approaches used in these two studies. Because the predictions made are remarkably similar, it can be assumed that the alternative formulations are in fact slightly different methods of approaching the same basic analytical conclusions.

SUMMARY

This model was developed to analyze the expected retention effects of pay increases proposed for military physicians. The specific results are based on Navy fully trained specialists using data from FY 1984 to FY 1988. The model indicates that many factors are important to physicians in deciding whether to stay in the Navy or seek civilian

employment. Increasing pay to the alternative civilian median level for each of 22 specialties studied would increase retention substantially but would not eradicate the perceived retention problem.

Physicians choose to leave based on many factors, some of which are not readily quantifiable, so increased pay will be unable to compensate some physicians sufficiently to convince them to remain in the Navy. Taking an approximate figure of 1,014 unobligated specialists in the Navy for fiscal year 1989, estimates indicate that about 314 of these specialists would choose to leave under the current 1989 pay plan. Paying the civilian alternative median income to all unobligated specialists would be expected to convince approximately 64 of these specialists to change their plans and stay in the Navy for at least one more year. Paying 90 percent of the civilian alternative median income to unobligated specialists would be expected to convert approximately 38 specialist losses into decisions to stay in the Navy for at least one more year.

The plan to pay 90 percent of the civilian alternative median would involve an average raise of $13,300, a 16-percent increase. Average pay to unobligated specialists in the Navy under the current pay plan is approximately $83,000. While the total cost of this plan is substantial, it is less than the cost of restoring lost purchasing power to physicians. Taking this into consideration, the raise in pay is a relatively modest adjustment on average and would be expected to lead to a significant increase in retention of unobligated specialists.

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1. The number in parentheses is an internal CNA control number.

APPENDIX A

FULLY TRAINED SPECIALIZATION FIELDS FOR NAVY PHYSICIANS

Table A-1. Classification of subspecialties

Specialty	Subspecialty	BUMIS specialty codes 1983-1985[a]	BUMIS specialty codes 1986-1987[b]
Family practice	Family practice	1618	1625
	Adolescent medicine	c	1626
	Gerontology	c	1627
Pediatric cardiology[d]	Pediatric cardiology	1615	1633
Pediatric neonatology[d]	Pediatric neonatology	1616	1642
Other pediatrics	General pediatrics	1613	1630
	Critical care	c	1631
	Oncology	c	1632
	Endo/metabolism	c	1634
	Gastroenterology	c	1635
	Hematology	c	1636
	Hem/oncology	c	1637
	Hematopathology	c	1638
	Allergy/immunology	1614	1639
	Immunopathology	c	1640
	Nephrology	1617	1641
	Neurology	c	1643
	Adolescent medicine	c	1644
	Infectious diseases	c	1645
Internal medicine, cardiology	Cardiology	1603	1604
Internal medicine, gastroenterology[e]	Gastroenterology	1605	1606

a. From *Manual of Navy Officer Manpower and Personnel Classifications*, NAVPERS 15839D, Vol. I (Major Code Structures).
b. From *Manual of Navy Officer Manpower and Personnel Classifications*, NAVPERS 15839F, Vol. I (Major Code Structures).
c. An old subspecialty code does not exist.
d. Population of 10 or less.
e. Population of 20 or less.

Table A-1. (Continued)

Specialty	Subspecialty	BUMIS specialty codes 1983-1985[a]	1986-1987[b]
Other internal medicine	General internal	1601	1601
	Critical care	c	1602
	Medical oncology	1609	1603
	Endo/metabolism	1604	1605
	Hematology	1606	1607
	Hem/oncology	c	1608
	Hematopathology	c	1609
	Allergy/immunology	1602	1610
	Immunopathology	c	1611
	Diagnostic lab immunology	c	1612
	Nephrology	1608	1613
	Pulmonary diseases	1610	1614
	Rheumatology	1611	1615
	Adolescent medicine	c	1616
	Infectious diseases	1607	1617
	Tropical medicine	1612	1618
	Gerontology	c	1619
Pathology	Anatomic/clinical pathology	1629	1585
	Clinical pathology	1630	1586
	Anatomic pathology	1628	1587
	Neuropathology	c	1588
	Dermatopathology	c	1589
	Forensic pathology	1631	1590
	Hematopathology	c	1591
	Radioisotopic pathology	c	1592
	Immunopathology	c	1593
Psychiatry	Psychiatry	1620	1675
	Critical care	c	1676
	Child psychiatry	1621	1677

a. From *Manual of Navy Officer Manpower and Personnel Classifications*, NAVPERS 15839D, Vol. I (Major Code Structures).
b. From *Manual of Navy Officer Manpower and Personnel Classifications*, NAVPERS 15839F, Vol. I (Major Code Structures).
c. An old subspecialty code does not exist.

Table A-1. (Continued)

Specialty	Subspecialty	BUMIS specialty codes 1983-1985[a]	1986-1987[b]
Radiology	Diagnostic radiology	1636	1650
	Pediatric radiology	1637	1651
	Neurologic radiology	c	1652
	Nuclear radiology	c	1653
	Therapeutic radiology	1625	1655
Obstetrics and gynecology (OB/GYN)	General OB/GYN	1510	1550
	Critical care	c	1551
	Maternal/fetal medicine	1511	1552
	Gynecologic oncology	1512	1553
	Perinatal biology	1513	1554
	Reproductive endocrinology	c	1555
	Gynecologic pathology	c	1556
Anesthesiology	Anesthesiology	1622	1540
	Critical care	1591	1541
General surgery	General surgery	1503	1510
	Critical care	c	1511
	Surgical oncology	1505	1512
	Renal transplant surgeon	1509	1513
	Colon-rectal surgeon	1506	1514
	Peripheral vascular surgeon	1508	1515
	Pediatric surgeon	1504	1516
Orthopedic surgery	General orthopedic surgery	1514	1530
	Pediatric orthopedics	1515	1531
	Hand surgery	1507	1532
	Spine surgery	c	1533
Neurological surgery[d]	Neurological surgery	1517	1522

a. From *Manual of Navy Officer Manpower and Personnel Classifications*, NAVPERS 15839D, Vol. I (Major Code Structures).
b. From *Manual of Navy Officer Manpower and Personnel Classifications*, NAVPERS 15839F, Vol. I (Major Code Structures).
c. An old subspecialty code does not exist.
d. Population of ten or less.

Table A-1. (Continued)

Specialty	Subspecialty	BUMIS specialty codes 1983-1985[a]	1986-1987[b]
Urology	Urology	1516	1560
	Pediatric urology	c	1561
	Urologic oncology	c	1562
Otolaryngology	Otolaryngology	1524	1565
	Head and neck surgery	c	1566
	Facial plastic and reconstruction	c	1567
	Otology	c	1568
Ophthalmology	Ophthalmology	1520	1570
	Pediatric ophthalmology	1521	1571
	Corneal and external disease	c	1572
	Retinal surgery	1523	1573
	Neuroophthalmology	c	1574
	Ophthalmic pathology	c	1575
	Oculoplastics	c	1576
	Facial plastic and reconstruction	c	1577
	Glaucoma	c	1578
Thoracic/cardiovascular surgery[d]	Thoracic cardiovascular surgery	1518	1519
	Thoracic surgeon	c	1517
Dermatology	Dermatology	1619	1660
	Dermatopathology	c	1661
	Derm immunology	c	1662
Neurology	General neurology	1623	1670
	Child neurology	c	1671
	Neuropathology	c	1672
Plastic surgery	Plastic surgery	1519	1525
	Facial plastic and reconstruction	c	1526
	Head and neck surgery	c	1527

a. From *Manual of Navy Officer Manpower and Personnel Classifications*, NAVPERS 15839D, Vol. I (Major Code Structures).
b. From *Manual of Navy Officer Manpower and Personnel Classifications*, NAVPERS 15839F, Vol. I (Major Code Structures).
c. An old subspecialty code does not exist.
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APPENDIX B

TRANSFORMATION OF BASIC MODEL FOR NONLINEAR LOGISTIC ESTIMATION

APPENDIX B

TRANSFORMATION OF BASIC MODEL FOR NONLINEAR LOGISTIC ESTIMATION

In this appendix, a brief description is given of the method of nonlinear estimation used to predict the probability that a specialist will choose to leave the Navy. The factors that are believed to influence the decision-making process of the individual physician are linked to a model that creates a prediction of the physician's choice. The nonlinear estimation technique used is a logit model, and the actual procedure used is the LOGIST Procedure available in the Statistical Analysis System (SAS) software.[1]

The basic model can be written as:

$$Y = a + \beta X + \epsilon \ ,$$

where

$Y = 1$ if the specialist chooses to leave the Navy
$Y = 0$ if the specialist chooses to stay in the Navy

X = a vector of factors that may influence the choice to leave the Navy or stay

β = a vector of coefficients for the X factors

a = a constant term

ϵ = independently distributed random variable with 0 mean.

The model can be transformed by considering the nature of the dependent variable. A decision to leave the Navy will be based on the input of a variety of factors, so that some index Z exists for each physician. Z is a theoretical but unmeasured continuous variable which represents the physician's attitude toward leaving the Navy. At some value of Z, a threshold is passed and the physician decides to leave the Navy. In this case:

$$Z = a + \beta X \ ,$$

where a, β, and X are defined as before.

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1. Duke University Medical Center, *The Logist Procedure*, by Frank E. Harrell, Jr. (SAS procedure for a logistic multiple regression model).

There is some Z^*, which represents a cutoff value that translates the unobservable index Z into a decision to leave or stay. Specifically:

Physician leaves the Navy if $Z > Z^*$,

Physician stays in the Navy if $Z \leq Z^*$.

The probability that a physician leaves the Navy is P. This probability can be written as:

$$P = F(a + \beta X) = F(Z)$$

where F is a cumulative probability function for the index Z, which is estimated by the factors in X. This function constrains the estimated probability of a leave occurring to lie within the (0,1) interval. The logit model is based on the cumulative logistic probability function and is specified as:

$$P = F(Z) = F(a + \beta X) = \frac{1}{1 + e^{-(a + \beta X)}} ,$$

where e represents the base of natural logarithms. The equation can be transformed into a form that can be estimated very simply. The equation becomes:

$$\log \frac{P}{1 - P} = Z = a + \beta X .$$

Over individual observations, P takes on a value of 0 or 1 for each physician in the sample. The estimated P will be the estimated probability that a choice to leave the Navy is made at a decision point.

One major advantage of the logit model is that the predicted probability that a physician will choose to leave the Navy is defined to be within the (0,1) range by the functional form of the estimated equation. Another advantage is that, unlike a simple linear probability model, the logit model allows the slope of the function to vary. The change in the probability associated with a change in one of the X variables will in fact be dependent on the particular value of that X variable and on the values of other X variables.

The form of the function implies that the model shows its greatest sensitivity when the probability of leaving is near .5. In other words, changes in the independent variables will have their strongest influence on the probability of choosing to leave or stay in the Navy at the midpoint of the distribution. If a physician has a strong preference to leave the Navy, for example, the influence of more pay is unlikely to cause that physician to decide to stay. However, if a physician balances various factors and is uncertain about leaving or staying, then pay can have a much stronger influence on the final decision.

APPENDIX C

LOGIT MODEL FOR THE PROBABILITY OF LEAVING: UNOBLIGATED SPECIALISTS

APPENDIX C

LOGIT MODEL FOR THE PROBABILITY OF LEAVING: UNOBLIGATED SPECIALISTS

Analysis indicates that the estimated logit model is quite stable. Results vary only slightly when different variables and specifications of variables are examined. The variables chosen yield a strong model with a high level of overall significance and good predictive ability. The variables used in the basic logit model are presented in table C-1 with their means and standard deviations, and brief definitions of the variables are given in table C-2.

Table C-1. Means and standard deviations of variables, FY 1984 through FY 1987

Variable	Mean	Standard deviation
Paydif	16,626.700	19,364.600
Same	.506	.500
Age	41.353	6.783
Yosd3	.242	.429
Yosd4	.184	.388
Yosd5	.105	.306
Depend	.881	.323
Ngrade	4.806	.846
Def	.049	.215
Ndef	.216	.411
EC	.174	.379
Berry	.071	.256
Mint	.225	.417

The logit model is used to calculate the elasticity of the probability of leaving with respect to the pay differential. Variation in the pay differential across physicians and across years is matched to individual physicians' decisions to leave or stay over up to four years, holding constant the effect of the other variables in the model. The elasticity is used to measure the sensitivity of physicians to pay gaps in their decisions to stay in the Navy or seek civilian employment. The formula is:

$$\text{Elasticity} = \frac{\text{percentage change in probability of leaving}}{\text{percentage change in pay differential}} .$$

Table C-2. Definitions of variables

Variable	Definition
Paydif	Pay differential between civilian alternative income and military income for the fiscal year observed
Same	Indicator variable for "taste" for military service. Dummy variable with 1 for repeat observations on the same physician across the 4 years
Age	Age of physician in years
Yosd3	Dummy variable: 1 indicates 10 or more years but less than 15 years creditable toward retirement at 20 years
Yosd4	Dummy variable: 1 indicates 15 or more years but less than 20 years creditable toward retirement at 20 years
Yosd5	Dummy variable: 1 indicates 20 or more years of service
Depend	Dummy variable: 1 indicates existence of dependents of the physician, either spouse or children or both
Ngrade	Indicator of rank of physician
Def	Dummy variable: 1 indicates scholarship (deferred status)
Ndef	Dummy variable: 1 indicates scholarship (nondeferred status)
EC	Dummy variable: 1 indicates early commission plan
Berry	Dummy variable: 1 indicates Berry plan
Mint	Dummy Variable: 1 indicates physician was nonwhite or female

From the overall sensitivity of the model, a separate sensitivity can be calculated for each of the specialty groups. This permits prediction of the effect of different pay raises by specialty to be translated into prediction of different retention results by specialty. The elasticity for each specialty is derived from:

- The overall estimated pay sensitivity of all physicians across 22 specialties and 4 years of data
- The most recently observed probability of leaving for physicians within each specialty

- The most recently observed level of the average pay gap for physicians within each specialty.

The specialties with the highest sensitivity to pay are, generally speaking, the surgical specialties.

The formula for specialty-specific elasticities can be written as:

$$\text{Elasticity}_j = \beta \times \text{Paydif}_j \times (1 - \text{Prob leave})_j ,$$

where

j indexes 1 of 22 specialties

β represents the overall sensitivity of specialists to pay differentials.

All observed pay differentials and probabilities are taken from data for FY 1988 by specialty. The estimated sensitivity of specialists to pay differentials, β, is based on analysis of all 22 specialties from FY 1984 to FY 1987. It should be noted that the probability of leaving is preliminary because the full data set is not yet available for FY 1988. However, the probability of leaving by specialty has been calculated very carefully, so it is not expected that any substantial differences will be observed when the data for FY 1988 are fully operational.

The probability of leaving by specialty is the actual probability rather than the predicted probability based on the model for two reasons. First, the actual probability permits data to be used from the most recent time period available, FY 1988. This has the advantage that it will reflect current trends of retention by specialty rather than relying on past patterns based on years characterized by generally higher overall retention. Second, while the model predicts the overall probability of leaving to be equal to the actual overall probability of leaving, actual probabilities often differ from predicted probabilities when examined by specialty. Therefore, it is more reliable to use actual observed probabilities rather than predicted probabilities in estimating specialty-specific elasticities.